RESPONSE OF LADINO CLOVER (*TRIFOLIUM REPENS* L.) TO CERTAIN ENVIRONMENTAL CONDITIONS AND MANAGEMENT PRACTICES

BY

LAWRENCE HUGH HANNAH

B.S., University of Illinois, 1946
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN AGRONOMY
IN THE GRADUATE COLLEGE OF THE
UNIVERSITY OF ILLINOIS, 1952

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RESPONSE OF LADINO CLOVER (*TRIFOLIUM REPENS* L.) TO CERTAIN ENVIRONMENTAL CONDITIONS AND MANAGEMENT PRACTICES

With the introduction of any new crop, fundamental data regarding its requirements, management and productivity are needed for its successful culture. This is true of the recently introduced legume, Ladino clover (*Trifolium repens* L.). In the past, few forage plants have become so popular with farmers in such a short time and over so large an area as has Ladino clover. This sudden popularity and the great value of the crop present a challenge to workers who are interested in Ladino's soil requirements, its possible winter-killing, its adaptability and its general management.

In order to determine what factors should be studied, a survey was conducted to determine what work was being done on Ladino clover at other experiment stations having soil and climatic conditions somewhat similar to those of Illinois. The problems mentioned most often were related to (1) fertility requirements and responses to fertilizer treatments, (2) winter-killing, (3) drought resistance, (4) persistency when seeded alone and in mixtures and (5) general growth habits of the plant. The investigations herein reported were designed to provide information that will give a better understanding of Ladino clover under the conditions which exist in Illinois.

With this in mind; two definite phases or problems were selected for study. They are presented under the following headings: I. Fertility and II. Winterhardiness. For the most part, these studies cover two crop seasons.

Methods And Materials

Greenhouse experiments were conducted using the surface soil of Cisne silt loam. The soil was collected from the Newton,

Illinois Soil Experiment Field. Results of the soil tests were as follows: the pH was 4.6; available P_2 was 16 pounds, which is considered very low; and available K was 64 pounds, likewise very low.

Greenhouse Experiment I. The objective of this experiment was to compare the response of alfalfa and Ladino clover to different fertilizers. The following amounts of fertilizers on a per acre basis were used: four tons of dolomitic limestone, having a 100 mesh size; $CaH_4(PO_4)_2$ in the amounts equivalent to 600 pounds of 0-20-0; 400 pounds of 60 per cent muriate of potash; 100 pounds of NH_4NO_3 and 60 pounds of borax. Seedings were made November 9, 1951, and three weeks later, all pots were thinned to four plants each. Two cuttings of forage were made, one on February 26 and the other on April 2, 1952. Oven dried weights were obtained. Charactistics studied in this test were yields of dry matter, heights of the two legumes immediately before cutting, nodulation of the roots, nitrogen percentage of the stems and leaves (as determined by the macro-Kjeldahl modified Gunning method) and the percentage on a weight basis of the stems and leaves of Ladino clover. Data were analyzed by analysis of variance method.

Greenhouse Experiment II was a study of the influence of molybdenum on yield, nitrogen content and nodulation of Ladino clover. The same phosphorus and potassium treatments indicated in the previous experiment were used. One half of the pots received lime, while the other half did not. MoO_3 was the source of molybdenum with rates of 1 and 10 p.p.m. of molybdenum applied to limed and unlimed soil. One cutting of the forage was made after which dry weights were recorded. The analysis of variance method was used to determine the significance of differences in the data.

Greenhouse Experiment III was a determination of the optimum pH range for Ladino clover. The same type of soil, phosphorus and potassium treatments as used in the two previous experiments were utilized in this study. Dolomitic

limestone, 100 mesh, equivalent to 1, 2, 3, 4, 5 and 6 tons per acre was added to the soil in different jars grouped in sets of three replications. Distilled water was used exclusively. After the forage was harvested, the soil was allowed to dry out and the pH of each replication was determined. Data were treated statistically by the analysis of variance method.

Field Test I. The object was to determine the rate of recovery of Ladino clover following cutting at different intervals in the fall of 1951 and subsequent survival the following spring. Forage was first harvested from all blocks on August 12, 1951. Cuttings at one-, two-, three-, and four-week intervals were made at a height of one inch. On April 26, 1952, counts were made of living plants on each plot. Data were analyzed by the analysis of variance method.

Field Test II. The objectives of this study were (1) to determine the influence of an ice sheet over Ladino clover plants on the survival of the plants and their subsequent growth, and (2) the consequence of low temperatures in the open and in a cold chamber. Foot-square blocks of soil in which the Ladino plants were growing were dug on February 13, 1952, and then placed in metal trays in a cold chamber at -8°C. An ice-sheet ⅜ inches thick over the blocks was obtained by spraying the tops with water. Then the blocks were turned over with the ice-sheet down on a metal tray filled with 1½ inches of water at 38°F. Five of the blocks were allowed to remain in the cold chamber without being covered with an ice-sheet. Stolons obtained from the field at the same time were frozen in ice blocks. Blocks from the cold chamber were removed at intervals of 4, 8, 12, 16 and 21 days and placed in soil benches in the greenhouse where they were allowed to thaw out and the living plants permitted to grow. After a severe change in temperature, foot-square blocks were dug from the field of Ladino clover, placed in the greenhouse and permitted to grow. Characteristics studied were (1) number of surviving plants and (2) height of plants. Data were treated by the analysis of variance method. Fall seedings of Ladino clover in pure stands were made in 1950 and 1951 and seed-

ings in the bluegrass sod were made in 1951. Observations on survival were noted.

Experimental Results

Greenhouse Experiment I. Alfalfa and Ladino clover responded quite similarly to the different fertilizer treatments. Greatest responses were obtained from the addition of potassium and phosphorus fertilizers. The total increase in yield from the use of a potassium fertilizer was two times greater for Ladino clover than for alfalfa. The influence upon the yield of alfalfa and Ladino clover was greater from the phosphorus fertilizer than from any other fertilizer used in the experiment. Observations made on the nodulation of the alfalfa and Ladino clover roots showed that both phosphorus and potassium favorably influenced the number and type of nodules. Different fertilizer treatments did not seem to affect the nitrogen content nor the percentage of the leaves and stems of Ladino clover.

Greenhouse Experiment II. The addition of small amounts of molybdenum to limed and unlimed soils did not greatly influence the yield of Ladino clover. The greatest increases were obtained from the addition of limestone to the soil having a low pH. Lime had a significant influence upon the nitrogen content, while molybdenum had a non-significant effect. No correlation was found between nitrogen percentage and yield of dry matter of Ladino clover. Molybdenum had no great effect on the number of nodules found on the roots.

Greenhouse Experiment III. Each increment of limestone up to and including three tons of limestone increased the forage production of Ladino clover. For each increment thereafter, a continued slight decrease in yield was noted. The optimum pH range in this experiment for growing Ladino clover in the greenhouse was found to be from 5.7 to 6.0.

Field Test I. Plots cut at one-, two-, three- and four-week intervals in the fall of 1951 were found to produce nearly equal amounts of dry forage. The plots cut every three weeks pro-

duced the greatest yields followed in order by those cut every week, every four weeks and every two weeks. Residual effects of the four cutting treatments the following spring showed that plots cut every four weeks had the greatest number of surviving plants, followed in order by the cutting treatments made at three-, two- and one-week intervals. On plots cut every four weeks, plants ranged from medium to strong in vigor, while those cut every three weeks were classified as medium. The remaining two treatments (cutting intervals of two and one week) had a rating of weak.

Field Test II. Ladino clover, covered by an ice sheet and exposed to low temperatures (-8°C) in a cold chamber, was materially affected. Percent of plant survival was found to be lower on blocks exposed merely to the low temperatures than on blocks covered by an ice sheet 1½inches thick. This apparently was due to more drying out of the stolons on blocks with no protective cover. Ladino stolons encased in ice had a lower survival percentage than those of the two previously mentioned treatments. The longer the plants were subjected to the different treatments, the lower was the survival percentage.

Blocks dug from the field, following a severe change in temperature and placed in the greenhouse showed that the winter temperatures of 1951-1952 had no detrimental effects on Ladino clover. Individual plants that had been marked in the field were not affected by the winter temperatures.

Pure Ladino seedings made in the fall of 1950 and 1951 were completely winter-killed. On the other hand, seedings made in the fall of 1951 in Bluegrass sod (*Poa pratensis*) were successful.

Discussion And Conclusions

A greenhouse experiment showed that alfalfa and Ladino clover responded similarly to different fertilizer treatments. Ladino yields were higher than alfalfa on soils receiving the LNPK, LPK and LK treatments. The addition of phosphorus

containing fertilizer to a Cisne silt loam soil gave marked increases in yield of Ladino clover. Very little benefit was realized from nitrogen when it was included in the fertilizer treatments.

Different fertilizer treatments had no effect on the percentages of nitrogen found in the leaves and little effect upon nitrogen content of the stem.

Larger and more numerous nodules were observed when phosphorus, or potassium, or both, were included in the fertilizer treatments than where these elements were not included.

Percentage of Ladino leaves varied from 61.9 to 65.6 and stems varied from 34.4 to 38.1. Soil treatments apparently had very little influence upon these percentages.

Molybdenum added to unlimed soil had very little influence on yield of Ladino clover. However, a small increase in yields was obtained when molybdenum at the rate of 1 p.p.m. and 10 p.p.m. was added to a basic treatment of lime, phosphorus and potassium. No benefit was realized from the use of molybdenum on either the percentage of nitrogen in the plant or on the formation of nodules on the roots. No correlation was found between yields and percentage of nitrogen in the crop.

Excellent responses were obtained from the addition of one, two and three tons of dolomitic limestone to a soil with an original pH value of 4.6. The optimum pH range for Ladino was found to be from values of 5.7 to 6.0. Ladino yields were found to decrease in response to applications of four, five and six tons of dolomitic limestone per acre.

No significant differences in total yields were found when Ladino was cut at intervals of one, two, three or four weeks. Plants growing in plots cut at intervals of four and three weeks showed medium to strong vigor the following spring. Plants growing in plots cut at intervals of two and one week were found to have low vigor the next spring.

A continuous low temperature (-8°C) without protective cover had more damaging effects on the survival of Ladino clover than an artificial ice-sheet which covered the plants for the same length of time. Reduction in number and size of surviving plants was found as the duration of exposure under an ice-sheet increased.

Fall seedings of Ladino seeded alone were killed by winter temperature, while fall seedings in bluegrass sod came through the winter successfully.

Normal winter temperatures at Urbana, Illinois, had no harmful effects on stands of Ladino established from spring seedings.

VITA

The author was born at Lodge, Illinois, on June 6, 1920. He attended pubilc schools at White Heath, Illinois, and in 1938, upon graduation from the Monticello Community High School, he entered the University of Illinois.

On January 6, 1943, the author entered the Army of the United States and served as an enlisted man in the Air Corps until he entered Cadet Training in July 1943. He was commissioned a Second Lieutenant in the Air Corps on June 26, 1944, as a pilot. He served as an instructor of Cadets in Basic Training, and later as first pilot on a B-17.

Upon discharge from the service in the fall of 1945, he returned to the University of Illinois and graduated in September 1946 with a degree in Vocational Agriculture. He then entered the Graduate College, receiving his Master's Degree in June 1947 in Agronomy.

After three years of teaching vocational agriculture at Oregon, Illinois, the author returned to the University of Illinois for further graduate work. In September 1951 he was appointed Assistant in Crop Production in the Department of Agronomy, teaching the beginning course of Crop Production.

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